Laurie Roth is a high-tech industry veteran of 35 years working for Hughes Aircraft Company in the US and Europe in positions of sales and marketing, and she led the semiconductor assembly equipment business unit that was spun out of Hughes to become Palomar Technologies, before joining Kulicke & Soffa. She is currently Director of Strategic Marketing at the corporation's Fort Washington HQ, Pennsylvania and co-chair of the IMAPS Global Business Council, which launched the Roadmap Initiative on behalf of IMAPS members.

which has been lost along the way. There's also the issue of speed at which higher bandwidth devices want to operate, and how to reduce the signal loss that occurs with every hand shake. And then power dissipation and thermal managment is a huge issue."

Roth notes: "Server farms are requiring whole new power plants, and governments which import energy are getting concerned about legislation on the amount of standby power. California has signed into legislation which designates the amount of volts devices can draw on in standby mode, and all new electronics is going to have to be redesigned for power management.

"By thoroughly evaluating the packaging content, we will be able to address the critical needs facing us through our advanced technology workshops, publications, and other IMAPS activities."

The first airing and a full update on the activities and findings of the IMAPS roadmap effort will be given at the IMAPS International Microelectronics Symposium, to be held in October at the San Diego Convention Center.

Roth says that a short and long version of the IMAPS version will be available to members, and work is under way with the European Union to put this together for Europe.

"IMAPS members look to the organisation for guidance as they steer their businesses and make career decisions," said membership VP Mike O'Neill. "A key goal of this IMAPS roadmap initiative is to clarify and focus the future of the industry for our members. We identify the gaps, so that our corporate members can focus on the solutions and grow their businesses by satisfying the acknowledged needs of the industry."

Key industry trends

- Profit margins for the packaging industry have been dropping.
- Capacity expansion conservative in the last three years creating constrained capacity.
- Overall R&D spending is dropping and shifting to low cost R&D centres in Asia.
- Material and subcontract pricing are increasing due to higher commodities pricing.
- Technologies under development increased and diversify for new device & materials.
- IP enforcement increasing and concerns over IP protection with the move to Asia.

Courtesy: iMaps

Anyone putting the terms "Freescale" and "semiconductor packaging" through the US patents database search will be greeted with a tsunami of 48 patent applications on as many packaging issues, filed since January 2005. So it comes as no surprise that Freescale's new Redistributed Chip Packaging (RCP) technology is based on some 13 patents, three of them new and the remainder to be granted soon.

Freescale's packaging revolution

In the history of packaging, the earliest ball grid array is attributed to Solid Logic Technology, second-generation polymer to Motorola (an IBM "ceramic" flip chip licensee) and Citizen in 1989, with the named honours going to Yoshihiro Shimada as the inventor of the BGA package. Now Freescale takes up the baton with RCP.

The proprietary RCP technique – which may well sweep away the traditional wire bond, BGA

and flip-chip approaches to packaging – integrates semiconductor packaging as a functional part of the die and system solution, and offers around 30% reduction in the packaged-die area and thickness.

It uses photolithography and copper plating steps to create chip to chip interconnects levels on both top and bottom die layers, connecting the dice top side for chip to chip connections and providing links to land grid arrays or C5 balls to the bottom system substrate.

"In low temperature coefficient ceramic (LTCC) technology the die is mounted on the substrate. With RCP the die is placed in a panel and the interconnect built around it," says Karl Johnson, director of Freescale's microwave and mixed signal technology laboratory, which has been working on RCP for some three to four years.

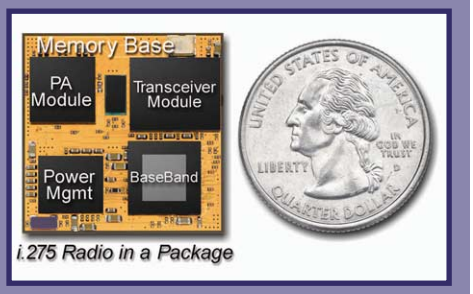
"One of the reasons that I have responsibility for the package assembly is that this involves RF and microwave technology, and part of my team works on development in III-Vs materials, and we develop advance module capability. These are very sensitive to packaging, but the very low stress technology of RCP allows package assembly to include transceivers, InGaP HBTs as well as the silicon chips.

"What pushed us in this direction is that as silicon technologies evolve and become ever smaller, the materials, such as low-k dielectrics, are fragile and brittle, and more and more levels are involved in multilevel stacks, which needs reduction of cross talk, great care in wire bonding and flip chip control to handle the stresses and delamination that occurs.

"With more functionality per unit area, we run into high input/output count, and the die size is limited then by the I/Os in the package, or limited by the flip chip pitch, leaving lots of white space. You find you are making design compromises in subsystems to accommodate these packaging limitations.

"If you look at assembly technologies in the industry, you will see a proliferation of specialty packages. We wanted our technology to achieve convergence again. We also had in mind that our customers were not asking for a simple single die, but for sub-systems and systems approaches with multiple die in a package, or package on a package. We were looking for technology for multiple die assembly and compatibility, and in our Tempe lab, have developed that capability."

Thinnest for how long?



Using RCP and PoP technology, Freescale has fabricated an i.275 radio-in-package measuring less than 25×25 mm. It contains all of the electronics for a 3G mobile phone including memory, power management, baseband, transceiver and RF front-end modules. Lead-free and RoHS compliant, RCP meets reliability standards for commercial and industrial applications. Development and tests are under way for automotive applications.

SiGe Semiconductor, Inc. claims the world's thinnest power amplifier for Wi-Fi systems with its RangeCharger SE2523BUi n a new paper-thin package with a profile of just 0.5mm. The ultra-thin design based on SiGe also reduces power consumption by 25%, making it ideal for embedding Wi-Fi capability into portable, battery-powered consumer electronics. It is a 2.4GHz PA that integrates digital enable circuitry, a power detector and biasing circuitry in a miniature 16-pin 3×3×0.5 mm QFN package. It features +18.5dBm power output with EVM of 2.5% operating in 802.11g mode. All ACPR requirements are met while operating at +23dBm output power in 802.11b mode. The integrated power detector improves the stability of wireless transmissions, being highly immune to mismatch: less than 1.5dB of variation with a 2:1 mismatch. The power detector offers two selectable power detector slopes, allowing it to be used with multiple chipsets. Also incorporated on-chip is digital enable control circuitry, which eases design by allowing the device to be connected directly to a CMOS baseband or transceiver. In production now, it is priced at US$0.79 in 10k quantities.

Johnson says that the prototype will transfer from the lab to a pilot line that will run in Tempe where the lab will "wring out all the high volume issues" while working with equipment and materials vendors, until the process is ready for "copy exact" to volume manufacturing lines in late 2007, and expected to ramp up in 2008.

Freescale is estimating it will produce 200m RCP chips using its own manufacturing lines for

Karl Johnson, director of Freescale's microwave and mixed signal technology laboratory.

PowerQuicc, DSP, baseband processors and PA lines. It is also willing to consider licensing and enable external packaging partners to use the technology.

"In many case we have used standard equipment, in other instances made modifications to equipment, working with vendors on capability," says Johnson.

"With manufacturing we will be going to 300mm panels and extremely high productivity.

Take the radio in the package (*top image on page 39*). In that system the substrate is used to mount the transceiver module, PA module, power management and baseband, embedded in the substrate with RCP memory dies. That is interconnected above and below and mounted in a POP configuration.

"We are particularly pleased that the technology is so very flexible. It can be used with single or multichip modules. Because it reduces stress between packaged dice, it can integrate silicon logic circuits with memories, passives, accelerometers, sensors and III-V devices. RCP is compatible with SIP, POP and integrated cavity packages," concludes Johnson.

"Packaging is often the last barrier in producing a commercially viable device," runs the website introduction to Optocap. "Leading-edge companies focusing on innovative design may not have the necessary expertise or equipment in house to develop the packaging required. However, considering up to 75% of the cost can lie in optoelectronic packaging solutions, it is critical that packaging design be integrated into the device development process in order to reduce product development cycle time and associated manufacturing costs."

Opto-packaging solutions house

Optocap engineer with a Palomar diebonder.

Optocap, located in Livingstone, Scotland was set up as a wholly owned subsidiary of Scottish Enterprise in 2003. The £4.2m funded facility is dedicated to commercialising device research by packaging optoelectronic, microelectronic, nanotechnology, MEMS, biotech, micro displays and sensor devices.

In a recent strategic alliance with high precision assembly equipment manufacturer Palomar Technologies AG, Optocap also now offers a process development and prototyping facility for Palomar customers in the communications, medical and automotive markets in Europe.

"European customers had a time window problem interfacing with the Palomar facility in California," says Optocap CEO, David Ruxton. "It